

# Contribution of mortality and disability to the secular trend in health inequality at the turn of century in Belgium

Herman Van Oyen<sup>1</sup>, Rana Charafeddine<sup>1</sup>, Patrick Deboosere<sup>2</sup>, Bianca Cox<sup>1</sup>, Vincent Lorant<sup>3</sup>, Wilma Nusselder<sup>4</sup>, Stefaan Demarest<sup>1</sup>

<sup>1</sup> Public Health and Surveillance, Scientific Institute of Public Health, J. Wytsmanstraat 15, 1050 Brussels, Belgium

<sup>2</sup> Interface Demography, Section Social Research, Free University of Brussels, Pleinlaan 2, 1050 Brussels, Belgium

<sup>3</sup> Institute Health and Society, Université Catholique de Louvain, Clos Chapelle aux Champs, 30.41, 1200 Brussels, Belgium

<sup>4</sup> Department of Public Health, Erasmus MC, University Medical Center Rotterdam, PO Box 2040, 3000 CA Rotterdam, The Netherlands

**Correspondence:** Herman Van Oyen, Public Health and Surveillance, Scientific Institute of Public Health, J. Wytsmanstraat 15, 1050 Brussels, Belgium, tel: +322 642 5037, fax: +322 642 5410, e-mail: h.vanoyen@wiv-isp.be

Received 4 May 2010, accepted 13 December 2010

**Background:** There is evidence that health inequalities by socio-economic status have persisted. We examined whether educational differences in Disability-Free Life Expectancy (DFLE) and Disability Life Expectancy (DLE) at age 25 has narrowed or widened between the 1990s and 2000s in Belgium. The contribution of mortality and disability prevalence to the secular trend is investigated. **Methods:** We used disability data from the 1997 and 2004 Belgian Health Interviews Surveys and mortality data from the 3-years follow-up of the 1991 and 2001 census population to assess education-related disparities in DFLE and DLE and to partition these differences into additive contributions of mortality and disability. **Results:** Compared to the highest educated population, differences in the prevalence of disability accounted for at least 66% of the inequality in DFLE. In the latest period, the differences in DFLE compared to men with tertiary education was 4.8, 6.6, 9.7 and 18.6 years for men with, respectively higher secondary, lower secondary, primary and no education. Among females, inequalities in DFLE were, respectively 5.8, 5.1, 10.8 and 18.2 years. There was no evidence that the educational differences in DFLE narrowed since the 1990s. Compared to people with the highest educational attainment, the inequalities in DFLE increased over time for all educational groups except for men with primary education. **Conclusion:** The social divide in health increased over time: people with the highest education continued to live even longer, they continued to live even longer without disability and to live less years with disability.

**Keywords:** Belgium, disability free life expectancy, health expectancy, inequity, life expectancy, socio-economic inequality

## Introduction

Deboosere *et al.*<sup>1</sup> showed that in Belgium, for the period 1991–2004, the increase in life expectancy (LE) in people with high educational attainment was larger compared to people with a low level of education. The widening of the inequality was present across the entire educational gradient. Increasing life expectancy is however only one facet of improving population health and it is important to evaluate if a longer life goes together either with a longer healthy life, indicative of compression of morbidity<sup>2,3</sup> or with an increase in unhealthy years or an expansion of morbidity.<sup>4</sup>

Changing both the length of life and the length of healthy life is a result of a simultaneous change in mortality and morbidity rates.<sup>5</sup> As mortality and morbidity are unequally distributed within societies, interpreting the change in the social distribution of population health needs a composite health measure that combines both prevalence rates of morbidity and mortality rates. For instance, a health

expectancy indicator categorizes LE in years lived without disability [disability free LE (DFLE)] and with disability [disability LE (DLE)]. Besides examining the quality in the additional years lived, it is important to understand how this change over time occurred. Is the trend in the social gap in DFLE or DLE mainly due to a change in the distribution of mortality or of morbidity? This question is essential because tackling inequalities in mortality and morbidity may need a different approach. The partitioning of the educational differences in DFLE and in DLE into a part due to mortality and a part due to disability is done using a decomposition method developed by Nusselder and Looman.<sup>6</sup> This method is a modification of the Arriaga method for decomposing differences in LE.<sup>7</sup>

Starting with the 1982 Black Report,<sup>8</sup> evidence has been accumulating that inequalities in health and mortality by socio-economic status have persisted and even widened.<sup>9–11</sup> This negative development was confirmed in a number of European countries, such as Denmark, France and the

Netherlands, which have studied trends in health expectancy indicators by social position over time.<sup>12–14</sup>

In this article, we examine (i) if in Belgium the social gradient in DFLE and DLE by educational level has narrowed or widened between the 1990s and 2000s and (ii) if there is evidence for a compression or expansion of morbidity by educational level. A third objective is to estimate the contribution of mortality and disability to the secular trend in the socio-economic inequality in DFLE and DLE.

## Methods

### Data

To assess LE, DFLE and DLE, data on mortality and disability are needed.

Mortality data were derived from a linkage of the 1991 and the 2001 censuses for a 3 years follow-up period with the National Register that includes data on vital status, using a unique identifier.

LE by educational attainment was calculated by year starting at age 25 years up to age 100 years.<sup>1</sup> To integrate the survey disability data in the life table, abridged life tables with 5 years age groups were constructed with a last open age interval at age 85 years.

The prevalence of the disability was obtained from the 1997 and 2004 Health Interview Survey. The methodological approach [http://www.iph.fgov.be/epidemio/epien/index4.htm: protocol (accessed 5 November 2010)]. In the 2004 survey, there was an oversampling of people of 65 years and older.] did not change between the two surveys. The National Register was used as sampling frame to select a sample using a multistage sampling method.<sup>15</sup> The number of subjects aged 25 years and over in the two surveys was, respectively 6763 and 9271.

### Socio-economic position

The socio-economic position was defined by the highest level of educational attainment. The census and Health Interview Survey used the same question and response categories. The educational attainment was recoded into five categories: no formal education, primary education (age 7–11 years; duration 6 years), lower secondary (age 12–14 years; duration 3 years), higher secondary (age 15–17 years, duration 3 years), and tertiary education.<sup>16</sup>

### Health domain

The Belgian Health Interview Survey has used the same instruments as proposed by the WHO-Europe working group to identify people with activity restrictions.<sup>17</sup> Activity restriction was used to define disability and was classified based on difficulties in doing one of seven ADL-functions (transfer in and out of bed, transfer in and out of chair, dressing, washing of hands and face, feeding, going to the toilet, continence), or having mobility problems (walking distance of maximum 200 m) or problems in seeing [inability of the interviewee (even wearing glasses) to recognize a person at a distance of 4 m] or in hearing (inability of the interviewee (even with a hearing aid) to follow a TV program at a volume others find acceptable).

### Health expectancy

The DFLE's and DLE's at age 25 years were calculated using the Sullivan method.<sup>18,19</sup> The mortality part of the variance was ignored when estimating the variance of the health

expectancies.<sup>20</sup> The hypothesis of equality of two health expectancies are conservatively tested by following Z-score:<sup>19,21</sup>

$$Z = \frac{DFLE_{(1)} - DFLE_{(2)}}{\sqrt{S^2(DFLE_{(1)}) - DFLE_{(2)}}} = \frac{DFLE_{(1)} - DFLE_{(2)}}{\sqrt{S^2(DFLE_{(1)}) + S^2(DFLE_{(2)})}}$$

$$\leq \frac{DFLE_{(1)} - DFLE_{(2)}}{S(DFLE_{(1)}) + S(DFLE_{(2)})}$$

The relationship between morbidity, disability and population health is often described in terms of compression or expansion.<sup>2–4</sup> Compression of disability occurs when the DFLE increases to a greater extent than the LE and hence the number of years with disability decline.<sup>22,23</sup> In all other cases, expansion of the disability prevails.

### Summary measures of socio-economic inequalities

Guidance for measuring inequalities in health suggests using both absolute and relative measures.<sup>24</sup> Because of the changes in the educational distribution over time, we used the Composite Index of Inequality (CII) as an overall population measure of inequality. The CII accounts for the population size of the educational classes.<sup>1</sup> The absolute CII (CII<sub>abs</sub>) is the sum of the weighted ( $w_i$ ) difference in the LE, DFLE or DLE between the educational groups and the tertiary education group category, with  $w_i$  proportional to the population size of the educational categories. The relative Composite Index of Inequality CII<sub>rel</sub> is the CII<sub>abs</sub> divided by the overall population's health expectancy and is interpreted as the percentage change in the overall health expectancy that would occur if all socio-economic groups had the health expectancy of the population with tertiary education. A decline in the CII<sub>rel</sub> of the DFLE implies a decrease in the inequality. For the DFLE, the CII<sub>abs</sub> and CII<sub>rel</sub> are:

$$CII_{abs} = \sum_i (DFLE_{Highest} - DFLE_i) * w_i$$

$$CII_{rel} = \frac{CII_{abs}}{DFLE_{Belgium}}$$

### Decomposition of the inequality in health

To estimate the contribution of mortality and disability to the inequality in health expectancy, a method of decomposition was used.<sup>6,25</sup> The inequalities in LE, DFLE and DLE are split into different parts: the proportion due to the inequality in mortality rates and the proportion due to the difference in the prevalence of disability. The first component is the 'mortality effect': the difference in person-years lived with or without disability that is due to a differential mortality. The second component, the 'disability effect', is the difference in person-years lived with or without disability because of differences in the prevalence of disability. Whereas inequalities in LE reflect differences in mortality rates only, inequalities in DFLE or DLE are a result of differences in mortality combined with differences in the prevalence of disability. Calculations were done using R [A copy of the R program and user manual are available from W. Nusselder (w.nusselder@erasmusmc.nl)].

## Results

Between the two censuses, there was a substantial increase in the educational attainment (table 1). In 2001, about one quarter of the population has a degree of tertiary education compared to <18% 10 years earlier. There are fewer people with no diploma in 2001 compared to 1991.

Educational inequalities in LE, DFLE and DLE are large (table 2). Generally, as educational attainment increases,

**Table 1** The distribution (in percentage) of the educational attainment in the 1991 and 2001 census, population 25 years and older, Belgium

| Education        | Males       |             | Females     |             |
|------------------|-------------|-------------|-------------|-------------|
|                  | 1991 census | 2001 census | 1991 census | 2001 census |
| Tertiary         | 17.6        | 25.4        | 15.1        | 23.8        |
| Higher secondary | 23.2        | 25.0        | 19.7        | 22.3        |
| Lower secondary  | 18.3        | 23.7        | 16.0        | 23.0        |
| Primary          | 14.9        | 15.5        | 17.2        | 19.2        |
| No diploma       | 26.1        | 10.3        | 32.0        | 11.8        |

LE and DFLE increase, while the expected years spent in disability decrease. For example in the latest period, the difference in DFLE between those with a tertiary education degree and those having no formal education was 18.6 years for men and 18.2 years for women. The difference in DLE between these two extreme educational groups was -11.1 years for men and -11.7 years for women.

In males, the increase in DFLE over time exceeded the rise in LE in all educational groups but men with higher secondary education (table 2). In the latter, the years without disability decreased about one year and the years with disability increased about three years providing evidence for an expansion of morbidity. In women, there was only evidence for compression in the population with primary education. In women with higher secondary education or without diploma, the DFLE decreased with, respectively >2 and 4 years and the DLE increased with 3.5 and 3.9 years.

Compared to people with tertiary education, the absolute difference in DFLE in both genders increased for all educational groups except for males with primary education (table 2). The increase of the inequality is not linear over the educational gradient. Substantial increases in the inequality were observed for men (4.0 years) and women (4.5 years) with higher secondary and for women with no formal education (6.8 years). The inequality in DLE increased especially for men and women with higher secondary (3.5 years) and for women with no diploma (3.9 years).

In order to account for the change in the educational distribution observed in table 1, we evaluated the secular trend using an 'overall' population measure of inequality, the CII (table 3). Among men, the CII<sub>abs</sub> changed from 7.3 to 6.2 for DFLE and from -4.1 to -2.9 for DLE. The reduction in the 'overall' inequality is mainly due to the decline in the proportion of men without a diploma. If the total male population had the mortality and disability experience of men with a tertiary education, the DFLE of the overall male population would increase by about 19% in the 1990s compared to ~15% in the 2000s, indicating a reduction in relative inequality. Among women, the increase of the inequality remained when the shift in educational attainment was accounted for (change in CII<sub>abs</sub> from 6.3 to 6.7 for DFLE and from -3.0 to -3.2 for DLE). The CII<sub>rel</sub> did not change and remained ~16–17%.

Tables 4 and 5 show the decomposition of the inequalities in LE, DFLE and DLE into a mortality and disability part. For example compared to men without a diploma, LE in men with tertiary education was 5.4 years greater in the 1990s. The latter were living 17.0 years longer without disability and 11.6 year less with disability. The difference in LE is only attributable to inequalities in the mortality rates. However, the DFLE and DLE inequalities are a result of inequality in both mortality and disability. Men with tertiary education lived 2.3 years longer without disability because they had lower mortality

rates (mortality effect) and 14.7 years longer because the prevalence of disability in this population was lower (disability effect). The 11.6 years less expected years with disability is partly a result of a lower mortality, which causes 3.1 more years to live with disability and a lower disability prevalence, which accounts for 14.7 years fewer years with disability.

Generally, disability accounted for two thirds or more of the inequality in DFLE. Compared to men with a tertiary education degree, the increasing inequality in years without disability of men with higher secondary education was mainly a result of the increasing disability prevalence. Inequality in DFLE (4.8 years) due to disability was +3.3 years (69%) in the 2000s compared to -0.4 years in the 1990s. The contribution of the disability effect to the inequality in DFLE increased also slightly in men with no diploma. In the other educational groups the contribution of the disability effect decreased in both the number of years, and as a proportion of total DFLE-inequality, indicating that over the decade of observation the part of the inequality in DFLE due to mortality difference became more important for those groups. The importance of the disability prevalence for the inequality in DFLE increased substantially for women with higher secondary and women without diploma. For women with higher secondary, the inequality in DFLE due to differences in the disability prevalence was in the 1990s 1.0 years out of the 1.3 years (72%) compared to 5.1 years out of the 5.8 years (88%) in the 2000s. Among women with no diploma, the disability effect on the DFLE inequality increased from 9.5 years (83%) to 16.0 years (88%). For women in the other two educational categories, the years of the inequality in DFLE due to the disability effect increased but as a proportion of the DFLE-inequality remained unchanged [primary education (86%)] or decreased [lower secondary (84% to 81%)].

## Discussion

In this article, we assessed whether, at the turn of the 21st century, the social divide in health narrowed or widened in Belgium. We determined the contribution of mortality and disability prevalence to the changes in socio-economic inequality.

Only among men there was some evidence for compression of morbidity. The increase in DFLE (+2.42 years) was larger than the increase in LE (+2.26 years) and therefore the years with disability decreased (-0.15 years). Among women, the change in DFLE was a little less than the increase in LE (respectively +1.51 and 1.57 years), so that the years with disability increased somewhat (+0.06 years). Generally, a higher educational attainment is associated with a longer LE, a longer DFLE and fewer years with disability. Compared to the highest educated population, differences in the prevalence of disability accounted for at least 66% of the inequality in years without disability.

There was no evidence that the social inequalities in health expectancy narrowed since the 1990s. People with the highest education continued to live even longer, continued to live even longer without disability and with fewer years with disability. The only exception is observed in men with a degree of primary education. In this group, the increase in DFLE exceeded substantially the increase in LE leading to a reduction of the inequality in DFLE and DLE and a reduction of the contribution of the disability effect to the inequality in DFLE, despite increasing inequality in LE. The increase in the inequality in DFLE was considerable among males and females with higher secondary education and among females with no diploma. In these educational groups

**Table 2** Life expectancy and expected years of life without and with disability at age 25 by gender and educational level, Belgium 1990s–2000s

|                                                | Males                            |                     |                         |         | Females                 |                     |                         |        |
|------------------------------------------------|----------------------------------|---------------------|-------------------------|---------|-------------------------|---------------------|-------------------------|--------|
|                                                | 1990s                            |                     | 2000s                   |         | 1990s                   |                     | 2000s                   |        |
|                                                | Life expectancy (years)          | Change <sup>a</sup> | Inequality <sup>a</sup> | Change  | Life expectancy (years) | Change <sup>a</sup> | Inequality <sup>a</sup> | Change |
| <b>Life expectancy (years)</b>                 |                                  |                     |                         |         |                         |                     |                         |        |
| Tertiary                                       | 52.83                            | 2.44                | 2.16                    | 2.66    | 58.25                   | 0.50                | 0.64                    | 2.36   |
| Higher secondary                               | 50.67                            | 1.94                | 3.12                    | 3.87    | 57.61                   | 0.75                | 1.12                    | 1.32   |
| Lower secondary                                | 49.71                            | 1.69                | 4.96                    | 5.79    | 57.13                   | 0.83                | 2.96                    | 1.27   |
| Primary                                        | 47.87                            | 1.61                | 5.37                    | 7.48    | 55.29                   | 2.11                | 3.66                    | 1.07   |
| No diploma                                     | 47.46                            | 0.33                |                         |         | 54.59                   |                     |                         | -0.50  |
| Total                                          | 49.17                            | 2.26                |                         |         | 55.60                   |                     |                         | 1.57   |
| <b>DFLE (years)</b>                            |                                  |                     |                         |         |                         |                     |                         |        |
| Tertiary                                       | 43.47 (42.14–44.80) <sup>b</sup> | 2.86                | 0.83                    | 4.79*   | 44.73 (42.55–46.91)     | 3.96*               | 1.32                    | 2.37   |
| Higher secondary                               | 42.64 (41.36–43.92)              | -1.10               | 6.04*                   | 6.62*   | 43.41 (41.75–45.07)     | 0.58                | 3.85*                   | -2.14  |
| Lower secondary                                | 37.43 (35.88–38.97)              | 2.28                | 10.84*                  | 9.68*   | 40.88 (39.24–42.53)     | -1.16               | 10.03*                  | 1.13   |
| Primary                                        | 32.63 (30.77–34.48)              | 4.02                | 17.00*                  | 18.58*  | 34.70 (32.58–36.82)     | 1.58                | 11.42*                  | 1.57   |
| No diploma                                     | 26.47 (22.00–30.94)              | 1.28                |                         |         | 33.31 (29.43–37.20)     |                     |                         | -4.39  |
| Total                                          | 38.05 (37.44–38.67)              | 2.42                |                         |         | 38.91 (38.15–39.67)     |                     |                         | 1.51   |
| <b>Life expectancy with disability (years)</b> |                                  |                     |                         |         |                         |                     |                         |        |
| Tertiary                                       | 9.36 (8.03–10.69)                | -0.42               | 1.33                    | -2.14   | 13.52 (11.34–15.69)     | -3.47*              | -0.68                   | -0.01  |
| Higher secondary                               | 8.03 (6.75–9.31)                 | 3.05                | -2.93*                  | -2.75*  | 14.20 (12.54–15.86)     | 0.18                | -2.73                   | 3.46   |
| Lower secondary                                | 12.29 (10.74–13.83)              | -0.6                | -5.88*                  | -3.89*  | 16.25 (14.61–17.90)     | 1.99                | -7.07*                  | 0.14   |
| Primary                                        | 15.24 (13.39–17.10)              | -2.41               | -11.63*                 | -11.10* | 20.59 (18.47–22.71)     | 0.53                | -7.76*                  | -0.50  |
| No diploma                                     | 20.99 (16.52–25.46)              | -0.95               |                         |         | 21.28 (17.40–25.16)     |                     |                         | 3.89   |
| Total                                          | 11.12 (10.51–11.73)              | -0.15               |                         |         | 16.70 (15.94–17.46)     |                     |                         | 0.06   |

a: Absolute difference

b: 95% confidence interval

\*Statistical significant difference at the 0.05 level

**Table 3** Absolute and relative CII<sup>a</sup> at age 25 years in total LE, DFLE and DLE, Belgium 1990s–2000s

|                            | LE    |       |                     | DFLE  |       |        | DLE    |        |        |
|----------------------------|-------|-------|---------------------|-------|-------|--------|--------|--------|--------|
|                            | 1990s | 2000s | Change <sup>b</sup> | 1990s | 2000s | Change | 1990s  | 2000s  | Change |
| <b>Males</b>               |       |       |                     |       |       |        |        |        |        |
| CII <sub>abs</sub> (years) | 3.21  | 3.25  | 0.04                | 7.34  | 6.19  | −1.15  | −4.14  | −2.94  | 1.20   |
| CII <sub>rel</sub> (%)     | 6.53  | 6.33  | −0.20               | 19.30 | 15.30 | −4.01  | −37.20 | −26.79 | 10.42  |
| <b>Females</b>             |       |       |                     |       |       |        |        |        |        |
| CII <sub>abs</sub> (years) | 1.98  | 2.47  | 0.48                | 6.25  | 6.69  | 0.44   | −2.97  | −3.21  | −0.24  |
| CII <sub>rel</sub> (%)     | 3.57  | 4.32  | 0.75                | 16.06 | 16.56 | 0.50   | −17.81 | −19.14 | −1.33  |

a: CII is estimated by educational level

b: Absolute difference

**Table 4** Decomposition of the inequality by educational level in LE and expected years of life without disability (DFLE) and with disability (DLE) at age 25 years into a mortality and disability part, Males, Belgium 1990s–2000s

| Education                           | 1990s |       |       |      |       |        | 2000s |       |       |      |       |        |
|-------------------------------------|-------|-------|-------|------|-------|--------|-------|-------|-------|------|-------|--------|
|                                     | LE    | DFLE  | DLE   | LE   | DFLE  | DLE    | LE    | DFLE  | DLE   | LE   | DFLE  | DLE    |
| Tertiary education                  | 52.83 | 43.47 | 9.36  |      |       |        | 55.27 | 46.33 | 8.94  |      |       |        |
| Higher secondary                    | 50.67 | 42.64 | 8.03  |      |       |        | 52.61 | 41.54 | 11.08 |      |       |        |
| Difference <sup>a</sup>             |       |       |       | 2.16 | 0.83  | 1.32   |       |       |       | 2.66 | 4.80  | −2.14  |
| Difference due to mortality effect  |       |       |       | 2.16 | 1.21  | 0.95   |       |       |       | 2.66 | 1.49  | 1.17   |
| Difference due to disability effect |       |       |       | 0.00 | −0.37 | 0.37   |       |       |       | 0.00 | 3.31  | −3.31  |
| Lower secondary                     | 49.71 | 37.43 | 12.29 |      |       |        | 51.40 | 39.71 | 11.69 |      |       |        |
| Difference                          |       |       |       | 3.12 | 6.05  | −2.93  |       |       |       | 3.87 | 6.63  | −2.75  |
| Difference due to mortality effect  |       |       |       | 3.12 | 1.60  | 1.52   |       |       |       | 3.87 | 2.26  | 1.62   |
| Difference due to disability effect |       |       |       | 0.00 | 4.45  | −4.45  |       |       |       | 0.00 | 4.37  | −4.37  |
| Primary                             | 47.87 | 32.63 | 15.24 |      |       |        | 49.48 | 36.65 | 12.83 |      |       |        |
| Difference                          |       |       |       | 4.96 | 10.84 | −5.89  |       |       |       | 5.79 | 9.68  | −3.89  |
| Difference due to mortality effect  |       |       |       | 4.96 | 2.53  | 2.43   |       |       |       | 5.79 | 3.17  | 2.62   |
| Difference due to disability effect |       |       |       | 0.00 | 8.32  | −8.32  |       |       |       | 0.00 | 6.51  | −6.51  |
| No diploma                          | 47.46 | 26.47 | 20.99 |      |       |        | 47.79 | 27.75 | 20.04 |      |       |        |
| Difference                          |       |       |       | 5.37 | 17.00 | −11.63 |       |       |       | 7.48 | 18.58 | −11.10 |
| Difference due to mortality effect  |       |       |       | 5.37 | 2.28  | 3.09   |       |       |       | 7.48 | 3.53  | 3.95   |
| Difference due to disability effect |       |       |       | 0.00 | 14.72 | −14.72 |       |       |       | 0.00 | 15.06 | −15.06 |

a: Difference with tertiary education

**Table 5** Decomposition of the inequality by educational level in LE and expected years of life without disability (DFLE) and with disability (DLE) at age 25 years into a mortality and disability part, Females, Belgium 1990s–2000s

| Education                           | 1990s |       |       |      |       |       | 2001  |       |       |      |       |        |
|-------------------------------------|-------|-------|-------|------|-------|-------|-------|-------|-------|------|-------|--------|
|                                     | LE    | DFLE  | DLE   | LE   | DFLE  | DLE   | LE    | DFLE  | DLE   | LE   | DFLE  | DLE    |
| Tertiary                            | 58.25 | 44.73 | 13.52 |      |       |       | 60.61 | 47.10 | 13.51 |      |       |        |
| Higher secondary                    | 57.61 | 43.41 | 14.20 |      |       |       | 58.93 | 41.27 | 17.66 |      |       |        |
| Difference <sup>a</sup>             |       |       |       | 0.64 | 1.32  | −0.68 |       |       |       | 1.68 | 5.84  | −4.15  |
| Difference due to mortality effect  |       |       |       | 0.64 | 0.37  | 0.26  |       |       |       | 1.68 | 0.70  | 0.98   |
| Difference due to disability effect |       |       |       | 0.00 | 0.95  | −0.95 |       |       |       | 0.00 | 5.13  | −5.13  |
| Lower secondary                     | 57.13 | 40.88 | 16.25 |      |       |       | 58.40 | 42.01 | 16.39 |      |       |        |
| Difference                          |       |       |       | 1.11 | 3.85  | −2.74 |       |       |       | 2.21 | 5.10  | −2.88  |
| Difference due to mortality effect  |       |       |       | 1.11 | 0.63  | 0.49  |       |       |       | 2.21 | 0.95  | 1.27   |
| Difference due to disability effect |       |       |       | 0.00 | 3.22  | −3.22 |       |       |       | 0.00 | 4.15  | −4.15  |
| Primary education                   | 55.29 | 34.70 | 20.59 |      |       |       | 56.36 | 36.27 | 20.09 |      |       |        |
| Difference                          |       |       |       | 2.96 | 10.03 | −7.07 |       |       |       | 4.25 | 10.83 | −6.58  |
| Difference due to mortality effect  |       |       |       | 2.96 | 1.41  | 1.55  |       |       |       | 4.25 | 1.57  | 2.68   |
| Difference due to disability effect |       |       |       | 0.00 | 8.62  | −8.62 |       |       |       | 0.00 | 9.26  | −9.26  |
| No diploma                          | 54.59 | 33.31 | 21.28 |      |       |       | 54.09 | 28.92 | 25.17 |      |       |        |
| Difference                          |       |       |       | 3.65 | 11.42 | −7.76 |       |       |       | 6.53 | 18.19 | −11.66 |
| Difference due to mortality effect  |       |       |       | 3.65 | 1.96  | 1.70  |       |       |       | 6.53 | 2.22  | 4.30   |
| Difference due to disability effect |       |       |       | 0.00 | 9.46  | −9.46 |       |       |       | 0.00 | 15.96 | −15.96 |

a: Difference with tertiary education

the change in inequality is largely due to increasing inequality in the disability prevalence.

Changes in population health may be affected by different and sometimes conflicting phenomena. Declining mortality tends to increase the duration and proportion of life in

ill-health, because more people enter into ages where the probability of unhealthy outcomes is high and because the life of the unhealthy is extended.<sup>26</sup> It has been suggested that expansion of disability goes with the highest LE and compression with the lowest.<sup>27</sup> This hypothesis may explain the gender

difference with evidence for compression among men and not among women but not the specific trend of the different educational attainment groups compared to the highest educational attainment, reported in this study.

A substantial part of the association between educational attainment and health is mediated through occupational position and income,<sup>28</sup> while other determinants such as knowledge, reversed selection and diminished access to health care only partially contribute to the main causal effect. The upward shift of the educational distribution as realized in Belgium is similar to the changes in most other European and OECD countries.<sup>29</sup> The size of the population with no formal education has reduced drastically. The composition of this population group may have changed towards a more extreme characterization of the social position in terms of lifestyles, social marginalization, poverty and possibly with a greater inverse health selection effect.<sup>10</sup> Both the more extreme characterization and the selection hypothesis are probable contributing factors to the very slow health progress within this subgroup, although it has been suggested that the explanation is more likely to be found in differential health behaviour.<sup>11</sup> Data from the health interview surveys in Belgium suggests that the socio-economic gradient in lifestyles increases among men and persists among women.<sup>30,31</sup> On the other hand, the democratization of the educational system in Belgium had a positive effect. When the change in educational distribution was accounted for, the size of the health gap reduces or even vanishes among males. Furthermore, the strongest improvement in health was observed in the population with tertiary education, indicating that there was no dilution effect.

We need to remain cautious when interpreting secular trends in health expectancy indicators. The Sullivan method uses prevalence data on morbidity and may therefore not be sensitive to sudden changes in population health.<sup>32,33</sup> Furthermore, the disability progresses in a non-linear way with increasing age<sup>34</sup> and changes in the disability prevalence reflect only partially the changes in incidence and transitions between health states as it is confounded by mortality rate and cure rate.

We are not aware of studies reporting on the contribution of mortality and disability prevalence to the secular trend in the socio-economic inequality in DFLE and DLE. Yet, our findings are in line with publications reporting on trends in inequality in health expectancy. Most comparable with respect to the time period and socio-economic variables used is a study which describes for Denmark a widening of the social gap in different health expectancy indicators by educational level for the period 1994–2005.<sup>13</sup> Earlier observations in France (1980–1991),<sup>12</sup> in the USA (1970–1990),<sup>35</sup> or in New Zealand (1981–1991)<sup>36</sup> did not find a narrowing of the social inequality in the health expectancy indicators. Only in the Netherlands a decrease in the social gap in morbidity-free LE was described (1989–2000), but in this study social differentials in mortality were not accounted for.<sup>37</sup> However, in a recent newsletter of Statistics Netherlands no change in the social inequality of different health expectancy indicators for the period 1997/2000–2005/2008 was reported.<sup>14</sup>

### Strengths and limitations

The current study has several strengths. LE by educational attainment is estimated through individual record linkage using a unique identifier present in both the census and mortality register files. The instrument used to classify education was the same in the census and health surveys and the methodology and questionnaires of the two surveys did not change.

A limitation of the study is the participation rate of 60% in both surveys. A selection bias, leading to an underestimation of the effect of low social position on poor health was documented.<sup>38</sup> Another limitation is the time shift between the mortality follow-up and the time of the survey for the first period. Previously a 6-year period of mortality follow-up has been used,<sup>25,39</sup> but it was reduced to 3 years to fit the follow-up time available for the 2000s period.<sup>1</sup> A last weakness of the study is related to the delay in coding causes of mortality in Belgium. We were not able, as was done previously,<sup>25</sup> to estimate the contribution of specific diseases to the gap in DFLE and LE for the latest period. This hampered the interpretation of the observed trends as we cannot assume that the relative contribution of different diseases to the social gap remains the same over time.

### Conclusion

The results of this article reinforce the conclusion on the secular trend in LE by educational attainment published previously.<sup>1</sup> The investment in human capital through education is essential in the fight to reduce the health divide but at the same time it is necessary to focus on the health situation of the lower educated, as in this group DFLE is substantially lower and the number of years with disability substantially higher. As the disability effect is the main contributor to the gap in DFLE, attention should be given to the prevention of disabling diseases which contribute substantially to differences in DFLE by educational attainment.<sup>25</sup>

### Funding

Belgian Science Policy (Service Public Fédéral de Programmation Politique Scientifique) [Society and Future:TA/00/15] through the TAHIB (Tackling Health Inequality in Belgium) project; European Public Health Program [2006109] through the EHLEIS (European Healthy Life Expectancy Information System) project.

### Key points

- Between the period of the 1990s and 2000s the trend of the Disability Free Life Expectancy (DFLE) at age 25 in Belgium suggests compression of morbidity among men; among women there is evidence for expansion of morbidity.
- At the turn of the 21st century, the inequalities in the DFLE at age 25 years between those with the highest education and those with a lower educational attainment have not narrowed.
- People with the highest education continued to live even longer, they continued to live even longer without disability and to live less years with disability.
- Compared to the highest educated population, differences in the prevalence of disability accounts for at least two-thirds of the inequalities in expected years without disability.
- As disability is the main contributor to the social gap in DFLE by educational attainment, health policy should focus on the prevention of disabling diseases.

### References

- 1 Deboosere P, Gadeyne S, Van Oyen H. The 1991–2004 evolution in life expectancy by educational level in Belgium based on linked census and population register data. *Eur J Population* 2008;25:175–96.
- 2 Fries JF. Aging, natural death and the compression of morbidity. *N Engl J Med* 1980;303:130–35.

- 3 Fries JF. Measuring and monitoring success in compression morbidity. *Ann Intern Med* 2003;139:455–59.
- 4 Gruenberg E. The failure of success. *Milbank Mem Fund Q Health Soc* 1977;55:3–24.
- 5 Crimmins EM, Hayward MD, Saito Y. Changing mortality and morbidity rates and the health status and life expectancy of the older population. *Demography* 1994;31:159–75.
- 6 Nusselder WJ, Looman CWN. Decomposition of differences in health expectancy by cause. *Demography* 2004;41:315–34.
- 7 Arriaga EE. Measuring and explaining the change in life expectancies. *Demography* 1984;21:83–96.
- 8 Townsend P, Davidson N. The Black report 1982. In: Townsend P, Whitehead M, Davidson N, editors. *Inequalities in health: the Black report and the health divide*. London: Penguin Books, 1992: 29–213.
- 9 Mackenbach JP, Stirbu I, Roskam AJ, et al. Socioeconomic Inequalities in Health in 22 European Countries. *N Engl J Med* 2008;358:2468–81.
- 10 Mackenbach JP, Bos V, Andersen O, et al. Widening socioeconomic inequalities in mortality in six Western European countries. *Int J Epidemiol* 2003;32:830–7.
- 11 Martikainen P, Valkonen T, Martelin T. Income differences in mortality: a register-based follow-up of three million men and women. *Int J Epidemiol* 2001;30:1397–405.
- 12 Cambois E, Robine JM, Hayard M. Social inequality in disability-free life expectancy in the French male population, 1980–1991. *Demography* 2001;38:513–24.
- 13 Bronnum-Hansen H, Baadsgaard M. Increase in social inequality in health expectancy in Denmark. *Scand J Public Health* 2008;36:44–55.
- 14 Bruggink J-W. Development in the (healthy) life expectancy by education. (In Dutch: Ontwikkelingen in (gezonde) levensverwachting naar opleidingsniveau.). *Bevolkingstrends* 2009;57:71–5.
- 15 Van Oyen H, Tafforeau J, Hermans H, et al. The Belgian health interview survey. *Arch Public Health* 1997;55:1–13.
- 16 UNESCO. *International Standard Classification of Education, ISCED* 1997. Montreal, Quebec, Canada, 1997: 1–31.
- 17 de Bruin A, Picavet HS, Nosikov A. Health Interview Surveys: towards international harmonization of methods and instruments. Copenhagen: World Health Organisation, 1996.
- 18 Sullivan DF. A single index of mortality and morbidity. *HSMHA Health Reports* 1971;86:347–54.
- 19 Jagger C, Cox B, Le Roy S, et al. Health expectancy calculation by the Sullivan Method: a Practical Guide, 3rd edn. 1–44. Montpellier, France. EHEMU Technical report 2006\_3.
- 20 Mathers C. Health Expectancies in Australia 1981 and 1988, 1st edn. Canberra: Australian Institute of Health: AGPS, 1991.
- 21 Abatih E, Van Oyen H, Bossuyt N, Bruckers L. Variance estimation methods for health expectancy by relative socio-economic status. *Eur J Epidemiol* 2008;23:243–49.
- 22 Robine JM, Brouard N, Colvez A. Les indicateurs d'espérance de vie sans incapacité (EVSI) Des indicateurs globaux de l'état de santé des populations. *Rev Epidemiol Santé Publique* 1987;35:206–24.
- 23 Robine JM. A new health expectancy classification system. In: Murray CJL, Salomon JA, Mathers CD, Lopez AD, editors. *Summary measures of population health. Concepts, ethics, measurement and applications*. Geneva: WHO, 2002: 205–11.
- 24 Keppel K, Pamuk E, Lynch J, et al. *Methodological issues in measuring health disparities*, 141 edn. Washington, DC: National Center for Health Statistics, 2005.
- 25 Nusselder WJ, Looman CW, Mackenbach JP, et al. The contribution of specific diseases to educational disparities in disability-free life expectancy. *Am J Public Health* 2005;95:2035–41.
- 26 Nusselder WJ. Compression or expansion of morbidity? A life table approach[dissertation]. Erasmus University Rotterdam, 1998.
- 27 Robine JM, Michel JP. Looking forward to a general theory on population aging. *J Gerontol A Biol Sci Med Sci* 2004;59:M590–7.
- 28 Lahelma E, Martikainen P, Laaksonen M, Aittomäki A. Pathways between socioeconomic determinants of health. *J Epidemiol Community Health* 2004;58:327–32.
- 29 OECD. *Education at a glance 2009*. OECD indicators. Paris, 2009: 1–472.
- 30 Charafeddine R, Van Oyen H, Demarest S. Trends in social inequalities in obesity: Belgium, 1997 to 2004. *Prev Med* 2008;48:54–8.
- 31 Drieskens S, Van Oyen H, Demarest S, et al. Multiple risk behaviour: increasing socio-economic gap over time? *Eur J Public Health* 2010;20:634–39.
- 32 Barendregt JJ, Bonneux L, Van der Maas PJ. Health expectancy: an indicator for change? *J Epidemiol Community Health* 1994;48:482–87.
- 33 Mathers CD, Robine JM. How good is Sullivan's method for monitoring changes in population health expectancies. *J Epidemiol Community Health* 1997;51:80–86.
- 34 Nusselder WJ, Looman CWN, Mackenbach JP. The level and time course of disability: trajectories of disability in adults and young elderly. *Disabil Rehabil* 2006;28:1015–26.
- 35 Crimmins EM, Saito Y. Trends in healthy life expectancy in the United States, 1970–1990: gender, racial, and educational differences. *Soc Sci Med* 2001;52:1629–41.
- 36 Davis P, Graham P, Pearce N. Health expectancy in New Zealand, 1981–1991: social variations and trends in a period of rapid social and economic change. *J Epidemiol Community Health* 1999;53:519–27.
- 37 Perenboom RJM, van Hertlen LM, Boshuizen HC, van den Bos GAM. Life expectancy without chronic morbidity: trends in gender and socioeconomic disparities. *Public Health Reports* 2005;120:46–54.
- 38 Loran V, Demarest S, Miermans PJ, Van Oyen H. Survey error in measuring socio-economic risk factors of health status: a comparison of a survey and a census. *Int J Epidemiol* 2007;36:1292–99.
- 39 Bossuyt N, Gadeyne S, Deboosere P, Van Oyen H. Socio-economic inequalities in healthy expectancy in Belgium. *Public Health* 2004;118:3–10.